AD-771 211

ACCURACY OF DETERMINATION OF REAL AZIMUTHS WITH THE Gi-C2 GYROTHEODOLITE

R. S. Sidorik, et al

Army Foreign Science and Technology Center
Charlottesville, Virginia

6 August 1973

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

DEPARTMENT OF THE ARMY
U.S. ARMY FOREIGN SCIENCE AND TECHNOLOGY CENTER
220 SEVENTH STREET NE.
CHARLOTTESVILLE, VIRGINIA 22901

TRANSLATION

In Reply Refer to:
FSTC-HT-23- 425-73
DIA Task No. T70-23-01

Date: 6 Aug 1973

ENGLISH TITLE: ACCURACY OF DETERMINATION OF REAL AZIMUTHS WITH THE Gi-C2 GYROTHEODOLITE

SOURCE: Geodeziya, kartografiya i aero'otos''emka, Issue 7, 1968, pp. 52-55.

AUTHOR: R. S. Sidorik and G. F. Mel'nikov

LANGUAGE: Russian

GRAPHICS NOT REPRODUCIBLE

COUNTRY: USSR

REQUESTOR: AMXRD

TRANSLATOR: Leo Kanner Associates, Redwood City, Ca. (Colten).

KEY WORDS
GYRO THEODOLITE
AZIMUTH
THEODOLITE
ANGLE MEASURING INSTRUMENT
INDUSTRIAL SPECIFICATION
GYROSCOPE
SURVEYING INSTRUMENT

COSATI SUBJECT CODE: 17;08;14
COUNTRY CODE: HU; UR

The Gi-C2 gyrotheodolite, made by the Hungarian firm MOM, was tested and found accurate up to $\pm$ 10". Comparative data and diagrams are included.

This translation was accomplished from a xerox manuscript. The graphics were not reproducible. An attempt to obtain the original graphics yielded negative results. Thus, this document was published as is, in order to make it available on a timely basis.

SI-73-54-163

NOTICE

p.8

The Gi-C2 gyrotheodolite (or gyro attachment) is manufactured at the MOM factory in Budapest, Hungary; its designer is Kossuth Prizo winner Ferenc Puzai. The instrument serves for automatic determination of real (astronomical) azimuths of directions and can be used in geodesic work on the surface of the earth as well as below the earth's surface, for orienting shafts, tunnels, etc.

The determination of azimuths with this instrument is independent of meteorological conditions, time of year, and time of day. The instrument can be used in the range of latitudes ±75°, in temperatures of the surrounding medium from -40°C to +50°C, with magnetic field strengths under 2 Oe, and in winds with velocities up to 5 m/sec.

The determination of the direction of the real meridian with the aid of the gyrotheodolite is based on the behavior of the main axis of a gyroscope with a pendulum suspension on which it swings under the influence of the daily revolution of the earth, in harmonic oscillations whose equilibrium position corresponds with the plane of the real meridian at the point at which the instrument is located.

The Gi-C2 gyrotheodolite consists of 4 main parts (see Fig. 1). A cross sectional view of the instrument is shown in Fig. 2. An overall view of the theodolite together with the gyroscopic attachment is given in Fig. 3. The heart of the instrument is the gyroscopic attachment, which is rigidly clamped to the theodolite with the aid of three fastening arms. Within the attachment (in the lower part) there is a gyromotor which is centered with a torsion suspension. For this a thin, narrow metallic ribbon is employed which is sufficiently strong to maintain the gyromotor in its operating position. When the instrument is not operating or when it is being transported the gyromotor is stopped.

A one-second optical theodolite is used as the angle-measuring part of the Gi-C2 gyrotheodolite. The telescope has a splitting prism instead of a hairline grid. Setting the dial to the desired angle is achieved by rotating a roller.

The Table gives comparative characteristics of gyrotheodolites manufactured in the USSR and in Hungary.

Fig. 1. Gi-C2 Gyrotheodolite.
1 -- gyroscopic attachment;
2 -- theodolite with tripod;
3 -- power supply (vibrator);
4 -- battery.

Table. Comparative Characteristics of Gyrotheodolites Manufactured in the USSR and in Hungary.

Characteristic	MT-1	Gi-B1	Gi-B2	Gi-C2
Accuracy, sec	20"	20"	12"	25"*
Time for one determination of an orienting direction (4 reversal points), min......	40-50	40-50	40-50	25
Suspension system	torsion	torsion	torsion	torsion
Tracking	automatic	manual	automatic	manual
Aggregate weight, exclusive of packaging, kg	47**	92**	70	35
Including in this:				
gyrotheodolite	16	21		9.3
tripod	18**	13		4.5
power supply	5.5	12		5.5
battery	7.5	19		15

Key: * from factory data; ** shipping weight, with packaging

A drawback of the Gi-C2 is the need to continuously observe the movement of the sensitive element

The azimuth of the orienting direction A is calculated according to the formula

$$A = M - N_0 + \Delta,$$

where M is the measured direction;

N_0 is the equilibrium position of the sensitive element, determined from the reversal points and the correction back to the null point; and

Δ is the correction of the gyrotheodolite.

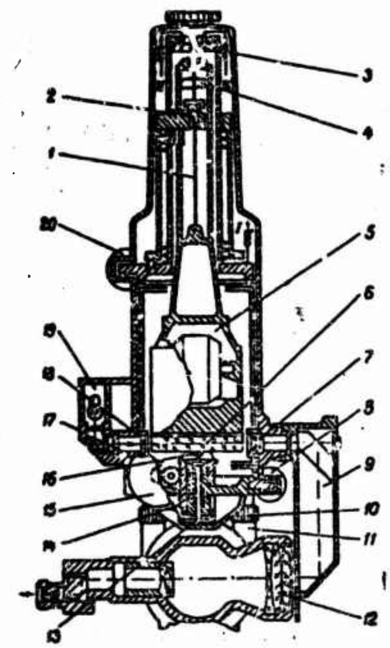

Fig. 2. Cross section of the instrument.
1 -- upper fastening end of the torsion system; 2 -- torsion system; 3 -- contact segments; 4 -- conducting spirals; 5 -- motor housing; 6 -- plate glass; 7 -- objective of the sensitive element; 8 -- adjusting screw for the instrument constant (parallelness); 9 -- basis prism; 10 -- safety tightening nut for brake; 11 -- fastening arm; 12 -- theodolite telescope objective; 13 -- screw for swing-damping system; 14 -- brake shaft; 15 -- knob of manual brake; 16 -- rubber membrane of damping system; 17 -- hairline grid of scale; 18 -- hairline grid of autocollimator; 19 -- light; 20 -- regulating screw of brake.

Field tests of two test samples of the Gi-C2 gyrotheodolite were performed in September and October of 1966, under various meteorological conditions and at different times of day. A few azimuth determinations were performed under nighttime conditions.

The accuracy of the instruments was determined by comparing the azimuth values measured by the gyrotheodolites with the values obtained from astronomic and geodesic observations with an rms error of ±2" - 3".

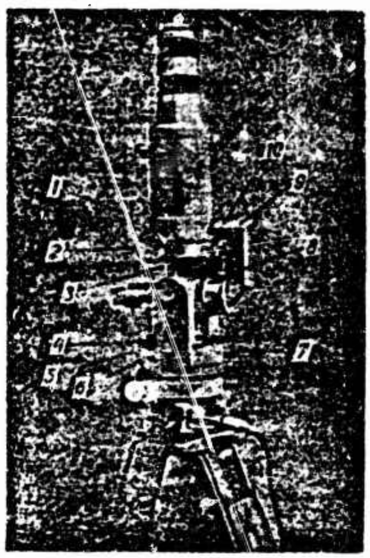

Fig. 3. Overall view of theodolite with gyroscopic attachment.
1 -- illuminator of sensitive element;
2 -- manual brake knob; 3 -- adjusting nut of safety brake; 4 -- vertical tightening screw; 5 -- vertical aiming screw; 6 -- handle for switching rings; 7 -- ocular for optical plumb-lining; 8 -- basis prism; 9 -- adjusting screw for the instrument constant (parallelness); 10 -- tightening lever for basis prism.

Over the period of the tests 42 runs were performed with the gyrotheodolite No. 853333, and 40 by the No. 853341. In each run the following steps were executed: 1) observation of two orienting directions; 2) determination of the null point from four reversal points before startup of the gyromotor; 3) startup of the gyromotor and determination of the equilibrium position of the sensitive element through four reversal points; 4) determination of the null point after braking of the gyromotor; and 5) observation of two orienting directions.

A deviation of ±1 division between two null point determinations was allowed. The air temperature and pressure and the wind velocity were also measured.

Before and after the observations, the correction constants of the gyrotheodolites were determined from 18 runs (9 runs before the observation and 9 after); these were stable over the entire duration of the work. The instruments were transported in a motor vehicle over dirt roads and highways (around 500 km).

The following rms errors of determination of azimuths were obtained from the tests: for gyrotheodolite No. 853333, ±12.3", and for No. 853341, ±10.2".

These data enable the conclusion that real azimuths can be measured with the aid of the Gi-C2 gyrotheodolite with an accuracy of ±15". Under favorable observation conditions and with a sufficiently experienced observer this can be increased to ±10". The instrument is convenient and simple to use. In contrast to the MT-1, the Gi-B1, and the Gi-B2, geodesic signals can be observed with it from columns [sic] and tables [sic]; and it does not require lengthy warmup.

A method of determining azimuths of directions using two gyrotheodolites in one run (4 reversal points) is very promising. Less promising but still quite so is a determination method using one gyrotheodolite with two runs. If the wind velocity is over 5 m/sec it is necessary to use a protective tarp.

The test results enable the conclusion that the Gi-C2 gyrotheodolite can be used for geodesy in the field -- for example, for orienting free geodesic grids, in plotting and linking theodolite and polygonometric courses (especially when there is no visibility between the points of the linking side), in resection, etc. Good results can be obtained by applying gyrotheodolites in combination with optical and radio telemeters.

Literature

1. Lavrov, V. N and I. B. Zhitomirskiy, "New Surveying Gyrocompasses: the MV2 and the MT1", Ugol', No. 1, 1965.

2. Lavrov, V. N., I. B. Zhitomirskiy, and Yu. S. Lukovatyy, "Gyroscopic Method of Determining Directional Angles", Geodeziya i kartografiya, No. 2, 1966.

3. Oglobin, D. N., "New Hungarian Surveying Gyrocompass, the Gi-B1", Gornyy zhurnal, No. 9, 1965.

4. Ogloblin, D. N. and V. N. Lavrov, "Surveying Gyrocompasses of the USSR and Foreign Countries", Ugol', No. 7, 1965.

5. Sergovskiy, Yu. V., "Test Results on Gyrotheodolites", Geodeziya i kartografiya, No. 1, 1966.

6. Feher Gyergy, "Testing the Gi-B1 Gyrotheodolite", Izv. vuzov, Geodeziya i aerofotos''emka, No. 4, 1964.

7. Ferenc Halmos, "Gyrotheodolites and Their Applications (Tests and Operating Experience with the Gi-B1 Instrument Made by the Firm MOM)", Ibid., No. 4, 1966.